X120 DouBLe DeNSiTy CoNVERSioN

EMERALO MICROWARE
X120 OOUBLE DENSITY BOARD
CONVERSION FOR THE
XEROX 820-1

HOW TO USE THIS MANUAL

There is more information in this manual then you will find
necessary to install your X120 board . Much of this information
is intended as reference material, or as assistance for people at
differing levels of experience. I recommend that you scan the
whole manual before attempting any modifications, and try to get a
clear picture of how the modifications can be easiest done on your
board.

The modifications are not complicated, but do require at least a
small amount of technical proficiency. If you do not understand
what needs to be done, feel free to call and ask, or locate
someone who has more experience of this sort.

X120 DOUBLE DENSITY BOARD
FOR THE XEROX 820-1

THEORY OF OPERATION

The X120 Double Density Board is a general purpose floppy disk
controller conversion, designed specifically for installation on a
Xerox 820-1 microcomputer board. Its physical layout is matched
to the 820-1 board so that it may be plugged directly into sockets
located at U109 (the old 1771 single density controller) and U117,
which handled most of the disk interface signals for the old
controller. The X120 board also has a composite video adaptor on
board, so that a standard composite video monitor may be used with
the 820.

WD2793-02 Floppy Disk Controller I.C.

The 2793 floppy disk controller chip is one of the most advanced
floppy disk controllers available today, with internal data
separation, disk size selection logic, internal precompensation
logic, "true" data bus, as well as software compatability with the
older 1771 and 1793 chips. Sector size and track stepping rates
may be changed by program control in its internal command
register. The phase-lock-loop data separator has the capability
of adjusting the data separation rate to match the variation of
different drives, with much better success than is found with
digital data separators. The size select logic allows very
convenient switching between 5 1/4" and 8" disk drives, with a
minimum of support logic.

X120 Double Density Board

The X120 double density board has many features designed in to
allow as much versatility and the best performance possible in a
double density conversion board.

Drive connection: There are three possible connectors that may be
used to connect floppy disk drives, J3 - 34 pin Shugart compatable
5 1/4" connector, J4 - 50 pin Shugart compatable 8" drive
connector, and the existing DB-37 connector on the Xerox board.
Each of these connectors is capable of driving terminated cables,
although it is recommended that your total terminating resistance
be no lower than 75 ohms (remember that terminated cable act as
resistances in parallel). J4 may also be used as a another 5 1/4"
connector by using the strapping option installed next to it to
change the lines that are not common to both configurations. Some
X120 boards do not have pins at the 15 and 16 locations to allow
clearance for a 34 pin connector (pin 1 is etched on the board,
next to the normal pin 17).

Size selection: The X120 board selects drive types by use of a
3X4 jumper array near the name and serial number at the top of the
board. A shorting jumper must be installed for each drive select
line to signal the 2793 which data separator and clock rate to
use. The jumpers are numbered left to right; DS1 (A drive), DS2
(B), DS3 (C), and DS4 (D), with 8" jumpers on the top and 5 1/4"
on the bottom. This selection also tells the 2793 whether or not
to use precompensation on double density "WRITES".

Drive selection: Drive selection is decoded from two-bit binary
drive select information which is sent on the existing DS lines
from the system port. This is decoded as (0,1)=DS1, (1,0)=DS2,
(0,0)=DS3, and (1,1)=DS4 (DS1 and DS2 are decoded the same as in
the standard 820-1).

Precompensation: Write precompensation is enabled in the standard
manner for 8" drives: enabled if DS=8" and the track number is
greater than 43 (TG43). The board also can be optionally strapped
to allow precompensation on 5 1/4" drives, for manufacturers that
recommend using it. 5 1/4" precompensation is used on all tracks
when it is enabled. The 2793 also has adjustable precompensation
which is enabled during all "READS".

Drive select from DS and MOTOR ON: An optional method of
selecting the drive is available which "ANDS" the drive select
line with the MOTOR ON line (the DS line will only be "TRUE" when
both the DS line and the MOTOR ON lines from the system port are
"TRUE"). In conjuction with this, it is possible to disable the
MOTOR ON signal to the 5 1/4" drives. This option may be
desirable in systems where +12vdc power is not adequate, since the
MOTOR ON signal will turn on the motors of all the 5 1/4" drives
each time it goes "TRUE". Most drives, on the other hand, may be
strapped to turn on the drive from the drive select line (this is
the way Xerox did it), thereby only turning on one drive motor at
a time. This configuration slows down inter-drive copying very
slightly, but not enough that it is noticable.

Composite video: The X120 board has a simple composite video
adaptor on board, to allow connection of common composite video
monitors to be used with the Xerox 820-1. This adaptor does not
interfere with the existing TTL video connector on the 820-1
board, and does not have to be used (or both may be used). The
video intensity can be adjusted using an adjustment pot on the
X120 board (an external 5K pot may also be used).

Adjustments: There are four adjustments that may be made on the
X120 board; write precompensation value, VCO centering, read
precompensation and video intensity. The precompensation and VCO
are preset on assembled and tested boards, and should not require
readjustment.

Alternate installations: The X120 board does not have to be
installed directly on the Xerox 820-1 board, but may also be
installed at any other convenient location using DIP jumpers
plugged into the sockets at J1 and J2. Both the 40 pin and the 16
pin (14 pin may be used with two separate wires for MOTOR ON and
DDEN) jumpers should be approximately the same length. In this
case, the existing sockets on the Xerox 820-1 board may be left on
and used.

Compatibility with other roms and bios': The X120 board may be
used in any system, as a replacement for a WD1771 controller. The
X120 board must have a source for the MOTOR ON, DDEN, SIDE, DS1,
and DS2 signals, which are not handled by the controller chip.

Output bit locations for the control lines are:

        MOTOR ON - U105 pin 8 - bit PA6
        DDEN -   U105 pin 9 - bit PA5
        SIDE -   U105 pin 13 (also U117-1)- bit PA2
        DS1 -   U105 pin 15 (also U117-3)- bit PA0
        DS2 -   U105 pin 14 (also U117-13)- bit PA1

U105 is the system PIO (also called the K80-FLOPPY PIO) located at
port 1C hex. U117 is a 7406 on the Xerox 820 board, which is
removed and replaced with a socket for connecting the X120 board.
These signals are passed to the X120 board by J1 which piggy-backs
onto U117 when the board is plugged in. DS3 and DS4 are decoded
on the X120 board (see manual section on theory of operation) from
the DS1 and DS2 lines.

The signals for the composite video adaptor are also passed
through the J1 connector. Either or both both sets of video
signals may be used at any time.

CONSTRUCTION HINTS
FOR THE X120 BOARD

Most of the components of the X120 board are very common and
should be very easy to find. Most of the TTL parts are listed as
'LS' parts, but may be any of the other possible designations,
however the best speed and loading are with the 'LS' versions.
The 7416's and 744S are open collector, and do not come as an 'LS'
(the 74LS241 seems to only come as an 'LS'). Most resistor and
capacitor values are fairly tolerant, within common sense limits.

The resistors at the output of the composite video determine the
background brightness of your video display. Be careful to
maintain about 470 ohms to the +5vdc, as some video monitors get
unstable with too much source current. If your display is unstable
feel free to experiment with these values, to find your best
display (you might even want to use an external pot in place of
the 5K, for an external brightness control). If you only seem to
have half of a display, check the notes about the 820 board in the
section on installation. The resistor combination on the RAW READ
signal is slightly more sensitive, as some disk drives do not
supply much voltage swing on this signal. If your unit cannot
read your disk, check pin 14 of the 74LS241 to make sure that
you're getting a string of pulses and not a fixed level. If the
pulses aren't there, but are there on the input side, try changing
the pull-down resistor (presently 470 ohms). The sip resistor
network is seven 270 ohm resistors tied together at one end which
is attached to pin one. The Sprague part number for this network
is QNP-2336-01. 220 ohm networks also seem to work fine. The
three variable resistor locations on the board have an extra hole
to allow you to mount a variety of different pots, in case you
can't find exactly what you want. The best seem to be the
horizontal mount, 3/8" square ones with the adjustment facing up.
The tiny 6mm. pots also work fine. The variable capacitor location
has even more spare holes, as caps seem to be less standard than
anything else. It's only necessary to use two of these holes, so
at least one pair of the 7 ought to work. Radio Shack sells a
trimmer (part # 272-1338 I think) that has range of 5-70 pf. but
doesn't fit the holes. These may be used by trimming the existing
leads back and soldering on a couple of pieces of wire to make new
leads. Capacitors in the range of 5-50 pf. seem to work fine
also.

The .1 mfd. cap in the pump circuit of the 2793 should probably be
a dipped tantalum or a polyester film, which have pretty stable
values and very low leakage currents. The value is set at .1 for
8" drives. The value for 5 1/4" drives is .22 mfd.; if you have
both sizes in the system, .15 or .18 mfd. is best. The positive
end (if it's polarized) of the cap should be towards the 2793.

The WD2793 may be a little bit hard to find a present, at least at
a reasonable price. The best price that I've found recently is
through B.G. Micro (Dallas, TX, 214-271-5546). The WD2791 will
also work here, but in this case you won't have to replace the
74LS242's on the 820 board (the reason that I'm not using the 2791
is that it's quite a bit more expensive).

The diode on the pump circuit is a 1N914, or any other general
purpose switching diode.

I have been using wirewrap dip sockets for J1 and J2 for a couple
of reasons. They are inexpensive, easy to find, add some
clearance over the 820 board, and when used with female headers
installed on the 820 board, form a very sturdy and reliable
connection. The female headers that I have been using come in a
36 contact strip which may be scribed with the tip of an Exacto
knife and broken off to length. They are made by A P Products,
part number 929974-01-36-R, and should be available at most
electronic parts stores. I don't recommend that you try using the
existing sockets on the 820 board as they come loose, or spring
out since they aren't made to handle such a large post (or don't
fit at all in the case of the hi-reliability sockets). The
existing sockets or chips shouldn't be too hard to remove with a
good solder-vac or wick. If most of the solder doesn't come out of
the hole the first time, add more solder and try again.

You have a number of options for connectors at J3 and J4. Standard
two row male headers work fine at these locations, but you may
want to consider using IDC connectors with ejector tabs if you
expect to be removing the cables frequently. These are also
available from A P Products, as well as many other sources. The
only interference problem that we have noticed on the board so far
is on J3, using a vertical IDC connector. On this connector the
additional plastic at the right end interferes with the 470 ohm
resistor next to the sip resistor pack. In this case, I have
trimmed a notch in the connector to clear the resistor.

The option and selection jumpers may be either hard-wire jumpered
with a small piece of wire, or you may want to install male pins
or headers at these locations. It is not necessary to use jumpers
at all of these locations, as there are jumpers etched on the
board in some cases such as A,C,D, and on the 8" - 5 1/4" select
for J4. If you wish to install jumpers at these locations you
should cut the default select before assembling the board. The
locations where you will need to install jumpers are F and the 8"-
5 1/4" DS lines. Check the strapping instructions for correct
settings.

Don't forget to replace the 74LS242's on the 820 board if you are
using a 2793 controller chip.

X120 DOUBLE DENSITY BOARD

DETAILED ASSEMBLY INSTRUCTIONS

The order that you install the components on your X120 board can make a considerable difference in the speed and convenience that you experience in your assembly. You should be sure to read the section on Construction Hints and Strapping before you begin. Use the Component Layout drawing as a placement and orientation guide.

TOOLS: Soldering iron, 15-35 watts (600 degree tip); rosin core solder, very thin; Exacto knife; flush cutters; working surface.

You may want to use sockets to mount your I.C.'s, at least your 2793. If you do, be sure to use good quality sockets. Many of the problems that are found with boards are caused by intermittant or tarnished contacts in sockets. Don't install the chips in the sockets until you are ready to begin testing.

You should try to avoid generating static electricity charges when you are handling your 2793, as these can cause it damage. If you expect this to be a problem, you may want to spread a piece of aluminum foil on your work surface with a wire running to a suitable ground. Touch the surface occasionally to dissipate any charges that build up on your body, and try to wear clothes that are less likely to cause static charges.

1. Collect the parts that you plan to use on the board.

2. Cut any default strap traces that you do not plan to use. If there is any question, it will be easier to do now than later. Carefully cut the traces between the two pads, and lift with the tip of the Exacto knife. Heating the trace with your soldering iron will help release it from the board.

3. Install I.C.'s or sockets. If you are careful, you can place all your I.C.'s or sockets in their locations, place a flat surface such as a book over them, and invert the board for soldering. I recommend that you solder only two leads of each chip, then go back and recheck that they are all properly oriented and in the proper location before completing your soldering. The labels on the chips should all read in the same orientation as the label on the board (the notch should also be the same as on the Component Layout Drawing).

4. Install fixed resistors, capacitors, and diode. Form the leads of each device and install them in their holes on the board. All of the component mounting holes are larger than the pass-thru holes. Double check the values of each device and solder them in. The diode's band will be towards the .18 mfd. pump capacitor.

Clip the excess leads flush to the board after soldering.

5. Install the variable resistors and capacitor. Most pots and caps will fit right in. If the leads are only slightly too large, they can sometimes be squeezed to shape using a pair of pliers.

6. Install jumpers. Male headers and shorting jumpers are about the easiest to use. Male headers often come on a double row strip that may be trimmed to the proper length using a flush cutter or Exacto knife. The 3X4 array can easily be made of two 2X3 strips placed next to each other. If they don't fit easily, turn one around, as most have an index notch in the side that will fit snugly against another. If you install the 3X6 array , do the same using three 2X3 strips. The 1X3 jumpers may be the hardest to make, but a 2X3 strip can generally be split up the middle (if its made of two single rows bonded together). Make sure you have the male pins exactly where you want them before you solder them in, as it is almost impossible to remove them without major damage to the board. If you don't expect to change the strap settings, wires such as the excess leads from resistors make very good hard-wire jumpers.

7. Install connectors. Male headers or IDC connectors may be used at J3 and J4 (see Hints). If you use IDC connectors, make sure that they are properly oriented, as most are polarized. Pin 1 of J3 and J4 is at the end where the J3 or J4 label is etched on the board. Wirewrap sockets are probably the best at J1 and J2. You may want to wire your composite video cable directly to the board. If you do, make sure that the signal carrying conductor is soldered to the pad with the lighter trace. Use a nonshorting connector such as a Phono (RCA) connector for the connection to your video monitor.

8. There are two holes to the left of the 74LS00 and the 10 mfd. filter capacitor. These are for connecting wires to the +5vdc. and ground (0vdc.) on the Xerox board. These should be used to guarantee that the X120 board gets a continuous, solid supply of power. The +5vdc. connects to the hole nearest the + sign.

9. Clean the flux from the bottom of the board using alcohol or flux remover. Inspect the board for good, clean looking solder joints. Also check for shorting to adjacent contacts due to excessive solder, splashes, or bent leads. On the component side, check that all values are correct, and components properly oriented.

10. Place chips in sockets and install shorting jumpers.

11. Proceed to Board Alignment instructions.

ALIGNMENT PROCEDURE FOR
THE X120 BOARD

You will need an oscilloscope with a bandwidth of at least 10Mhz. to accurately align the X120 board. The alignment procedure should not need to be repeated if the settings are not disturbed.

The calibration of the X120 board is best done while the board is installed on the 820. The DS lines should be in the 8" position, and the DDEN line pulled low. The TEST jumper (F) should be installed initially, and pin 19 of the 2793 pulsed low (RESET) to initialize the chip. The F jumper should then be removed for calibration. The TEST pin (2793 pin 22, also the left end of the F jumper) should be pulled low during calibration (make sure that the F jumper is in - pulled high, whenever you RESET).

VCO CENTER FREQUENCY ADJUSTMENT

The VCO center frequency is adjusted by placing the scope (or frequency counter) probe on pin 16 of the 2793 and adjusting for a frequency of 500 kHz. This frequency may not be correct if the DDEN line and the DS jumpers are not in the correct state.

READ PRECOMPENSATION

Read precompensation is enabled on all read operations. This adjustment is the most likely to cause a board to not be able to read. With the scope probe on pin 29 of the 2793 adjust the 50K RPW pot until you get a pulse 250 nanoseconds long.

WRITE PRECOMPENSATION

This adjustment only affects the 2793 during double density write operations. In most cases this will only be used on 8" drives unless you enable S 1/4" precompensation by jumpering B. With the scope probe on pin 31 of the 2793, adjust the 10K WPW pot until you get a pulse wideth of 150-200 nanoseconds (Shugart 8" drives only; 150 ns. for both S 1/4" and 8" precomp; or 75-150 ns. for Shugart 5 1/4" drives only). Most 5 1/4" drives work fine without precompensation (consult your OEM manual).

Reinstall the jumper at F. The board is now calibrated and ready to be installed on the 820 board for use.

X120 DOUBLE DENSITY BOARD

STRAPPING OPTIONS

The X120 double density board has a number of options which may be implimented to maximize the performance of your double density system. Some of these are labeled by letters etched on the board, and all are listed on the component layout. Some of these have a default option etched directly on the board, which should be cut before assembly if the alternate is to be used. The top of the board is the edge with the copyright statement.

OPTION:

A - Enable S 1/4" Motor-On line. Default=enabled.

B,C - S 1/4" write precompensation. B=disabled(default). C=enabled.

D,E - (Drive Select and Motor-On). D=drive select from DS lines only (default). E=drive select when both DS and Motor-On lines are true.

F - WD2793 Set-up and test. Jumpers WD2793-22 to +5vdc for normal operation. Ground pin 22 for calibration of VCO and precompensation times.

Drive Select Size - 4X3 jumper at top of board. Jumper correct disk size for each drive that you use. The sizes are marked to the left of the jumpers, 8" on top and S 1/4" on the bottom. Unused drive lines should be jumpered as 8". Lines are numbered from the left; DS1, DS2, DS3, and DS4 on right (nearest the 7445).

J4 Size Configuration - 3X6 jumper near J4. J4 may be used as either a 8" or 5 1/4" drive connector, but 6 of the signal lines must be changed depending on which is used. Jumpers should either be all 8" (default, to the right), or all S 1/4" (to the left). NOTE - a 50 pin connector can be used for both size drives if pins 15 and 16 are removed, and you are using unpolarized connectors or open male headers.

Connector Polarities:

J1 - Pin 1 is same as chips.
J2 - Pin 1 is same as chips.
J3 - Pin 1 is to the right top (nearest 74LS241)
J4 - Pin 1 is to the top left (labeled) for 8" and at pin 15 (8" designation) for 5 1/4" (labeled).
J5 - Pin 1 is at bottom (lighter trace).

X120 DOUBLE DENSITY BOARD

INSTALLATION

**** READ THIS COMPLETELY BEFORE BEGINNING ANY MODIFICATIONS. IF
THERE IS ANYTHING THAT YOU DO NOT UNDERSTAND OR CANNOT DO, EITHER
RETURN THE PACKAGE OR SEEK ASSISTANCE ****

NOTE There are at least two different Xerox 820-1 boards in
circulation, the 140P82629A (I'll call it the 629A board) and the
140P82664A (664A). These can be identified by the etching near
the J4 connector on your board. These boards have differences in
the floppy controller and video display circuitry. All of the
schematics that I have seen have been for the 664A. The
modifications are slightly different for the boards, so mods that
apply to a specific board will be followed by the board number in
parenthesis. The 629A board is also missing the grounds on the
odd numbered pins of its J8 connector (parallel port). These pins
should be grounded before using this connector for a Centronics
port. The 629A board's video circuit has an additional delay on
the horizontal sync signal for use with Ball monitors. If you are
using a different monitor or one without an adjustable sync delay,
you will find that only the right half of your display will work.
This can be remedied by soldering a 10K resister in parallel with
R10 (located just below U14) on your board.

The tools that you will need to install the X120 board are:
electronics grade soldering iron (15-35 watt, 600-700 degree tip),
solder (thin rosin core), desoldering tool (solder wick or
solder-vac), small needle nose pliers or forceps, diagonal
cutters, and an Exacto Knife.

There are several ways that each change can be installed on your
board. If your board is fully socketed, the easiest way to break
a circuit is to simply pull out the chip, bend out the lead, and
replace the chip in the socket. This can also be done if your
chips are soldered in, but it is not as simple. In this case the
lead should be desoldered using a solder-wick or solder-vac.
Check to make sure that the lead is fully loose from the board, to
avoid damaging the traces. Gently work the lead out of the hole
using a pair of small needle nose pliers or a pair of forceps.
The most common way of breaking a circuit is by making a small cut
in the trace going to the lead. This method must be done by
carefully making two cuts in the trace about 1/16" apart (be
carefull not to cut yourself, or any of the other traces). Heat
the short trace between the cuts with your soldering iron to
loosen it and remove it using the tip of your Exacto Knife. This
method is much harder to repair if you make a mistake, but it can
be done if you keep your cuts short enough and have enough copper
left to solder a piece of fine wire to.

PIN #11

1. Remove the chips and sockets at U109 and U117 on your Xerox
820-1 board (take note of the pin on U117 that the video mod is
connected to). These will be replaced with different sockets.

2. Remove R67, R49(664A), and C137(664A). These are pull-up
resisters and a decoupling capacitor that are no longer necessary.

3. Remove chips at U110 and U119 (74LS242's) and replace with
74LS243's. This will put "true" data from the 2793 on the data
bus.

4. Remove U105-10 (U105, pin 10) from its socket or make a small
cut in the traces between U105-10 and J1-2, and U105-10 and U107-1
(see figure 1 and 2). This disables the 8/N5 size select input to
the Z80-PIO. Check all your cuts with an ohmmeter to make sure
that they are open (infinite resistance).

5. Solder a 1K resistor between U107-1 and U107-16 (+5vdc.). This
selects the proper clock signals for operation of the 2793.

6. On the component side, either cut the trace between U105-8 and
U104-3 (see figure 2), or bend out pin 3 of U104. Jumper U104-3
(the pin on the chip, not the board) to U104-7 (ground). This
disables the alternate character set of the character generator,
since U105-8 is now the MOTOR ON signal.

7. Place a 1/8" X 1/2" piece of electrical tape adjacent to pins 7
and 8 of U117 (actually between U117 and R59 or over the old C137
location on the 664A). This will insulate the new pins 8 and 9 of
U117 from the traces on the board.

8. Solder the two 20 pin female strip headers in place of the U109
socket. The best way to maintain alignment is to insert a 40 pin
wirewrap socket (24 pin will do) into them before soldering.

9. Bend out or break off one of the end pins of each of the 8 pin
headers, and solder a piece of 30 gage wire to the contact in the
socket (they may come this way). These will be the new pins 8 and
9 of U117.

10. Solder the two 8 pin headers into the U117 position, with the
pins with wire on them over the electrical tape. Use a wirewrap
socket to keep them aligned.

11. Solder the wire from U117-8 (you just put it there) to U105-8,
and the wire from U117-9 to U105-9. These are the new MOTOR ON
and DDEN signals.

12 - Remove U105 - pin 8 & 9 (as you did
pin 10, step #4)

12. If you are planning to use J1 on the Xerox board to connect
your floppies, you will need to make this modification:

G64A board- Cut the trace between U94-6 and U109-27, or if your
board is socketed, bend out U94-6.

629A board- Cut the trace between U107-4 and U109-27, or bend
out U107-4 if your board is socketed.

Both boards- Jumper U108-4 to U109-27. This is easiest on the
back of the board.

At this point you should be able to plug in your X120 board and
run double density.

There are two holes on the X120 board adjacent to the 10 mfd.
filter cap at the end of the 74LS00. These are connections for
+5vdc and ground (0vdc). In order to guarantee good stable supply
voltages to the X120 board, these should be wired to a good source
of +5 and ground (such as the ends of C134) on the 820 board.
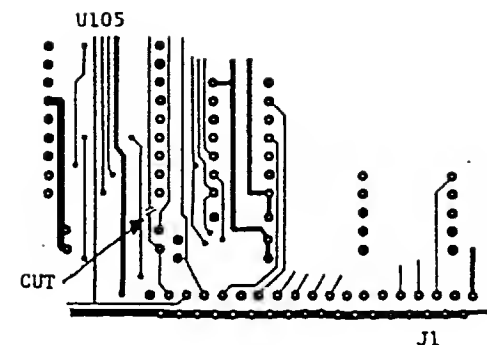
SOLDER SIDE

FIGURE 1
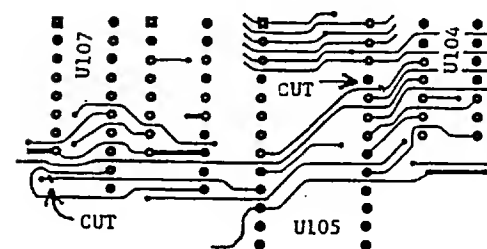
COMPONENT SIDE

FIGURE 2

104P82664A BOARD (629A BOARD IS SIMILAR)

PARTS LIST - X1208 P.C. BOARD

| LOCATION	QTY.	PART NUMBER	DESCRIPTION
C1	1	22 mfd 50 vdc	tantalum filter cap.
C2	1	.18 mfd 50 vdc **	tantalum cap. - pump
C3	1	5-70 pfd **	variable capacitor - vco
C4-C7	4	.1 mfd	by-pass capacitors
D1	1	1N914	diode
J1	1	40 pin dip plug **	plug to U109 (1771)
J2	1	16 pin dip plug **	plug to U117 (7406)
J3	1	34 pin header	5 1/4" interface
J4	1	50 pin header	8" interface (34 pin hdr for optional 5 1/4" int.)
J5	1	2 pin header	composite video out
R1	1	270 ohm resistor network **	7 resistor network with pull-up on pin 1
R2,R5	2	470 ohm	
R3,R7	2	1K ohm	
R4,R6	2	270 ohm	
R8	1	10K ohm variable	(write precomp adj.)
R9	1	50K ohm variable	(read precomp adj.)
R10	1	5K ohm variable	(video intensity)
U1	1	WD2793-02	floppy controller
U2	1	74LS08	quad and gate
U3	1	74LS86	quad exclusive or gate
U4	1	74LS00	quad nand gate
U5	1	74LS10	tri 3-in nand gate
U6	1	74LS04	hex inverter
U7	1	74LS241	octal buffer
U8-U10	3	7416	hex inverter- o.c.
U11	1	7445	decimal decoder- o.c.

** See Construction Hints for alternate values, sources, and special considerations.

STRAPS: 3X4, 1X2 header array (.025 square post) required, with 5 shorting straps. 1X3(2 ea.),1X2, and 3X6 headers are optional.

MISC. PARTS: 1X20(2 ea.) and 1X8(2 ea.) female headers for mounting in U109 and U117 on XEROX 820-1 board (A P Products #929974-01-36-R) 74LS243(2 ea.) for replacing the 74LS242's at U110 and U119 on the 820-1 board
small amount of 30ga. insulated wire
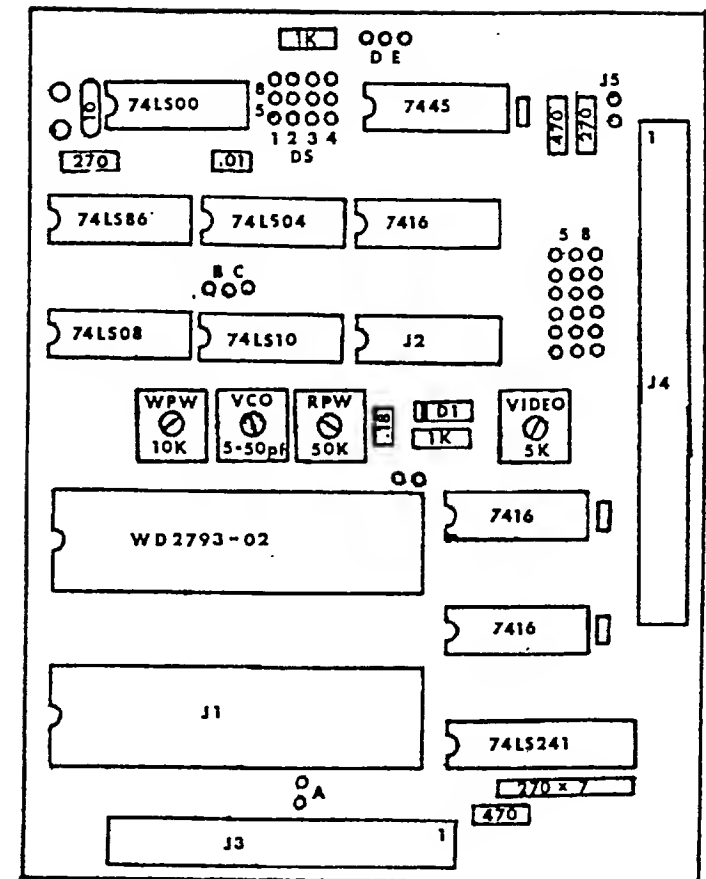
X120 BOARD COMPONENT LAYOUT

WARRANTY POLICY

Emerald Microware warrants the X120 board and the X-8 ROM package
to be free from defects of material and workmanship for a period
of 90 days. Defective materials will be repaired or replaced at
the vendors option. A thirty day satifaction guarantee is also in
effect provided parts are returned in their original shipping
materials and condition. Money will be refunded on receipt and
inspection of returned materials, less shipping and handling
charges. Return authorization should be obtained in advance by
calling (503) 642-1860, or writing to Emerald Microware, P.O. Box
6118, Aloha, OR 97007. No other warranties as to the
applicability or performance of the product are either expressed
or implied.

SOFTWARE AND FIRMWARE UPDATES

Updates to firmware and software may be periodically available to
enhance its performance or correct bugs as they are located.
Original owners will be motified of any major changes, which will
be offered at a minimal fee. Changes may also be obtained by
1200/300 baud modem, between the hours of 10 p.m. and 8 a.m.
Pacific time, by calling (503)-642-1860. This bulletin board will
begin operation after Oct. 1, 1984.
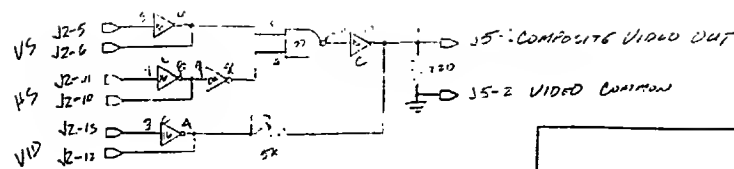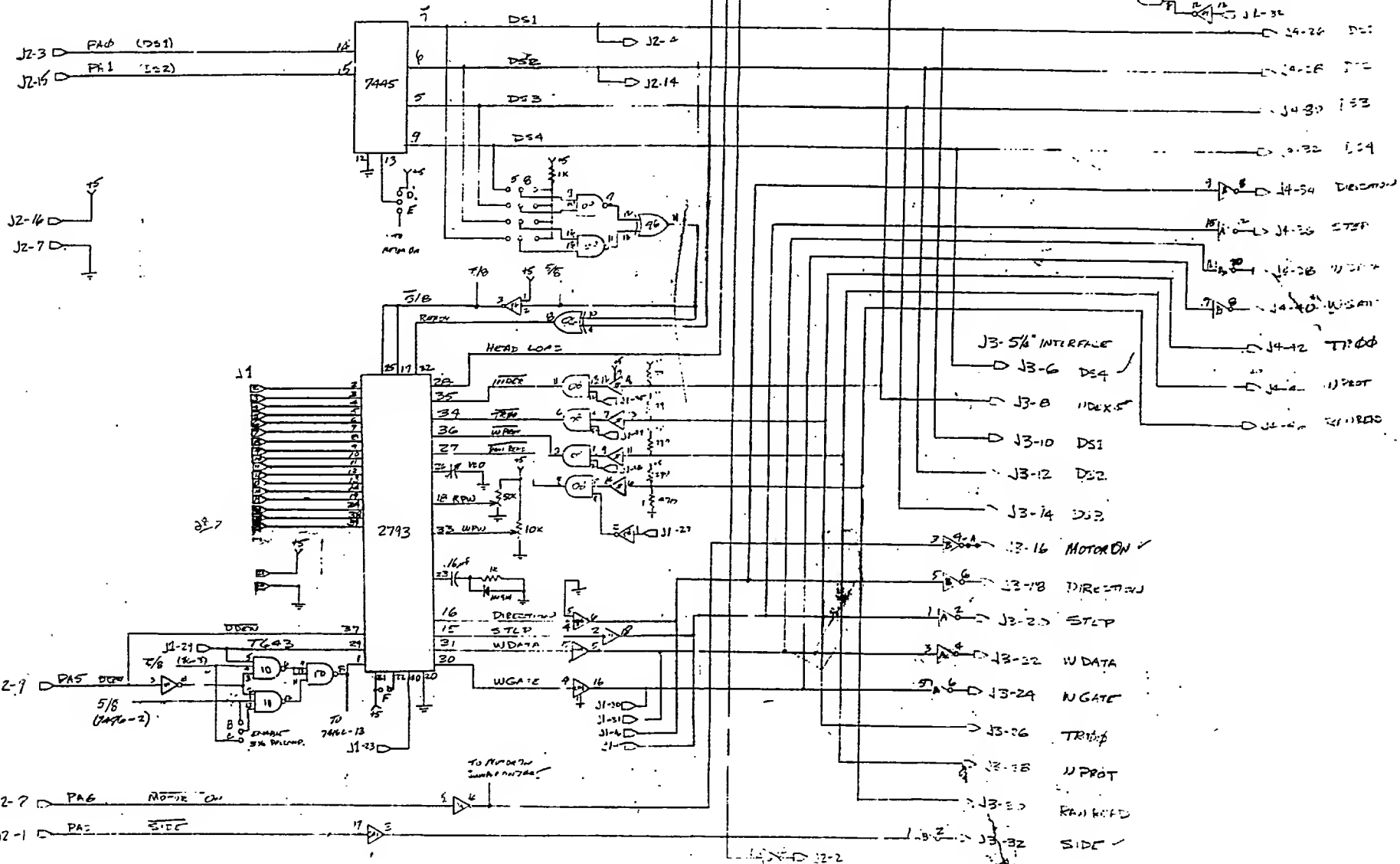
***** IMPORTANT NOTE *****   One signal has accidently been overlooked on the X120B double density board. This is the 8" HEAD LOAD signal that returns to the 820 board. In its present state the heads on any 8" drive that is connected to the J1 (37 pin) connector on the 820 board will stay loaded. To correct this, simply place a small jumper wire between pin 28 of the 2791 (2793 maybe) and pin 28 of J1 on the X120 board. This will restore normal head load operation to your 8" drives. This jumper is only necessary if you plan to connect your 8" drives using the 37 pin connector at J1 on the 820 board. The signal is already correctly implimented on the X120 J4 connector. It is also unnecessary to install the TEST jumper (F) for normal operation, as the 279x chips have an internal pull-up resistor.

-8" DOUBLE DENSITY OPERATION   You need to upgrade your clock rate on your XEROX 820 board to 4 or 5 Mhz to be able to run your 8" drives on double density. This is not necessary to run 5 1/4" double density. This is because the data transfer rate for 8" drives is twice as fast as for 5 1/4" drives, and the processor can't quite keep up at 2.5 Mhz. The conversion to 5 Mhz is fairly simple, since all of the necessary signals are already present on the board, providing of course that the components on your board are fast enough to keep up. Most of the factory assembled boards have RAM that is fast enough, but many of the Z80 components (PIO, SIO, CTC, & CPU) are not. You may find that replacing these chips, though not very expensive, is more work or more complicated than you want to undertake. The CPU should be a '8' rated part, with the rest being at least an 'A' rating. The actual modication is this:

    Cut the CAS trace between U11 pin 5 and U25 pins 11 or 13
    Cut the MUXC trace between U11 pin 4 and U71 pin 1
    Cut the 2.5 Mhz trace between U10 pin 4 and U9 pin 3
    Jumper U11 pin 4 to U25 pins 11 and 13
    Jumper U11 pin 3 to U71 pin 1
    Jumper U10 pin 5 to U9 pin 3

This completes the 5 Mhz modification. The modification to run 4 Mhz is the same, but you will need to replace your 20 Mhz crystal with a 16 Mhz, and change your floppy disk clock rates by removing U12, and jumpering U12 pin 8 to U10 pin 5, and U12 pin 9 to U10 pin 4. The 4 Mhz modification seems to be a bit more touchy than the 5 Mhz, and I recommend that you only use it if you know that the parts in your board will only make the 4 Mhz rate.

GOOD LUCK,   BG 10/2/84 (revised 12/5/84)

The Emerald Microware X120 Double Density adaptor board may be used on the Ferguson Big Board I, as well as the Xerox 820-1, since they are functionally the same board. However, some of the parts are not the same, and in any case have different locations on the board. The installation is slightly less elegant, in that though J1 can still plug into the WD1771 location, but a single ended dip jumper is necessary to pick up and return the signals that are handled through J2. The crystal for the baud rate generator will also need to be laid down, as with other upgrades. You can ignore the composite video adaptor on the X120 board, since the BBI already has this feature. The SYSPIO which is U105 on the Xerox board is U111 on the BBI, and the WD1771 is U102. The 7445 at U109 is the only component that needs to be removed from the BBI, and no cuts should be necessary. I do recommend that the 1771 socket be replaced with female headers for best installation. The signal list for J2 on the X120 board is as follows:

J2 pin	Big Board I, chip-pin
1	U111-13
2	NOT USED, CAN BE RUN TO BBI J1-4
3	U111-15
4	U109-1
5	VIDEO VSYNC, NOT NECESSARY
6	VIDEO VSYNC RETURN, NOT NECESSARY
7	GND, 0 VOLTS
8	U111-8
9	U111-9
10	VIDEO HSYNC RETURN, NOT NECESSARY
11	VIDEO HSYNC, NOT NECESSARY
12	VIDEO RETURN, NOT NECESSARY
13	VIDEO, NOT NECESSARY
14	U109, 2
15	U111,14
16	+5 VOLTS DC

Only the signals connecting to U111 are necessary if you do not plan to use J1 to connect 8" drives on the BBI itself. If J1 on the BBI is to still be used to connect drives, pin 4 of U104 should be pulled out of its socket, and connected to pin 14 of U104, and a jumper is required on the X120 board between J1-28 and the 2791 pin 28 to return the HEAD LOAD signal to the BBI. The DVSEL2 and DVSEL3 signals are not returned to the BBI, but may be picked up from pins 5 (DVSEL2) and 9 (DVSEL3) of the 7445 on the X120 board if they are needed. The BBI will now have true side select capabilities also.

+2 Rom Set

Plus2 ROMset

for the

Xerox 820/BigBoard

using the

Emerald Microware X120 board

October, 1985

B. Installation

!!! BEFORE YOU INSTALL YOUR ROMS, PLEASE READ THE FOLLOWING !!!

There are two prerequisites to installing the Plus2 ROMs. You should have

    (1) a Plus2 configured bootable disk, and

    (2) a screwdriver.

NOTE: Although it is possible to boot on either an Xpro or a standard Xerox single-density disk, there are versions of both which directly access and/or modify hardware ports or monitor memory locations. These versions will NOT properly boot on the Plus2 ROMs.   _Letter_ →↓_NOT 1_

To create a Plus2 bootable disk, refer to section I. It is recommended' that at least two Plus2 bootable disks be generated before installing the Plus2 ROMs.

The second part of installation is fairly simple: CAREFULLY remove the ROMs from locations U63 and U64 (see Note). Slide your screwdriver under both ends of each original ROM, and gently lift them EVENLY out of their sockets. (Make sure the screwdriver is ABOVE the ROM sockets, NOT between the sockets and the circuit board.) Install the Plus2 ROMs in the socket indicated on the ROM. The label on each ROM should face towards the top of the board (opposite the disk and keyboard connectors).

NOTE: BigBoard ROM sockets are numbered differently; the U63 ROM should be installed in BigBoard socket U68 and the U64 ROM in BigBoard socket U67.

6

Initialization

pressing the RESET button, the monitor performs a CRC self-
   of the ROMs and a test/initialization of the monitor RAM
ry (F000H-FFFEH). If an error occurs, the monitor will stop
display the cause. After finishing this check, the monitor
ls the RAM portion of the monitor into high memory, sets all
tor values to their default settings, and proceeds with
tem initialization".

em initialization (re-)initializes the computer port
igurations, sets the default baud rates, and resets the drive
ing table so that logical and physical drives are identical.
rol is then passed to the Resident Monitor whose functions
   described in section E. System initialization also occurs
i the CTRL + ESC keys on the Xerox high-profile keyboard
pressed (user-modifiable).   B

two external serial ports (SIO-A or COMM; SIO-B or PRINTER)
initialized in the monitor as follows:

COMM (SIO-A) 8-bit data, 1 stop bit, 16x clock,
              no parity, 1200 baud

PRINTER (SIO-B) 7-bit data, 1 stop bit, 16x clock,
               odd parity, 1200 baud

7

0. Plus2 v0.01 Features

Included below is a list of features offered in the Plus2 v0.01 Monitor. All user-modifiable parameters can be changed under program control, but are usually defined in the boot sector of a Plus2 booteble disk by the P2CNFG utility (so that your system always boots with your customized settings).

DISK CONTROL

The monitor is written to accomodate motor control of both 5.25 and 8 inch disk subsystems. Either the disk select lines or the MOTOR ON line can serve the function of disk motor control for 5.25 and 8 inch disk systems. When the drives are activated end MOTOR ON is inactive, a delay occurs while 5 sector holes are counted (user modifiable), allowing the disk to achieve proper speed. If there is no drive activity for 12 seconds (user modifiable), the drives are deselected.

Whenever a drive other than the current one is selected and MOTOR ON is already active, the monitor will optionally count sector holes for turnon (useful if your 8" drives have motor control via the select lines). In this case, the sector hole count for 5.25 and 8 inch drives are separately definable.

DISK FORMATS

A number of popular disk formats have been included with the Plus2 ROMs. These are:

5.25 inch
   - Xerox single-sided single-density
   - Xerox double-sided single-density
   - Xerox 820-II single-sided double-density
   - Xerox 820-II double-sided double-density
   - Keypro single-sided double-density
   - Kaypro double-sided double-density
   - Kaypro quad (double-sided double-density 96-tpi)
   - Osborne single-sided single-density
   - Osborne single-sided double-density

8 inch
   - IBM 3740 (BigBoard/Xerox single-sided single-density)
   - Xerox double-sided single-density
   - Xerox 820-II single-sided double-density
   - Xerox 820-II double-sided double-density
   - Xpro single-sided double-density
   - Xpro double-sided double-density
   - SWP 596k single-sided double-density
   - SWP 1192k double-sided double-density
   - SWP 670k single-sided double-density
   - SWP 1340k double-sided double-density

LOGICAL-TO-PHYSICAL DRIVE MAPPING

Plus2 incorporates logical-to-physical drive mapping which allows you to name your drives in any manner. For example, if you boot on physical drive C, this becomes logical drive A. It is possible to map the logical drives to any physical drive (or even the same physical drive).

AUTOMATIC DETECTION OF QUAO ORIVES

If you have or should you decide to install quad drives (double-sided 96-tpi) in your system, Plus2 detects them without any modifications to your system disk. Any 48-tpi disk will also work properly in the quad drives. Further, you can even boot a 48-tpi Plus2 system disk on a quad drive.

REAL-TIME CLOCK

Using the capabilities of the Z80-CTC chip, a real-time clock has been incorporated into the monitor. The Plus2 ROMs come preconfigured for 4 MHz operation; however, if you have another system clock speed (either 2.5 or 5 MHz), the CTC chip will be reprogrammed for the proper clock rate upon boot of a Plus2 system. Vectors are present in the monitor jump table which can be used by QP/M to fetch the current date/time.

The new monitor always runs the real-time clock and will start at 00:00:00 unless set. 24-hour format is used (e.g. the clock "rollover" to 00:00:00 occurs after 23:59:59).

Along with the real-time clock, a calendar has been incorporated into the monitor. This is a fully-functioning 365-day calendar (it does not check for leap years).

System re-initialization will not affect the current clock setting.

FERGUSON RAMCARD SUPPORT

The Plus2 ROMs along with the Plus2 BIOS fully support the Ferguson 256k and 1Meg RAMcards. If you configure your system disk for Ferguson operation, drive M: is available as a 192k (960k) RAM drive immediately after boot (no extra utility required).

SCREEN DISPLAY OF TIME

Another feature of the new monitor is an optional screen display of time. Pressing <CTRL> + <BACKSPACE> on the Xerox 820 keyboard (user-definable) toggles the clock display on/off.

PROGRAM ABORT

At any time (except maybe following a crash), it is possible to reset the computer system without pressing the RESET button on the back of the system. This is done by pressing <CTRL> + <ESC> on the Xerox 820 keyboard (user-definable). It is also possible to disable this feature as described in section K.

Program abort will re-initialize the ports, but leave any monitor RAM data intact (including the current setting of the real-time clock).

SCREEN DUMP

A screen dump to the printer is accomplished every time the <CTRL> + <HELP> key is pressed on the Xerox 820 keyboard (user-definable). If the BIOS has not been loaded into memory, the monitor will use the serial PRINTER port as the LIST device. After the BIOS is loaded, the monitor will use whatever LIST device is implemented in your BIOS. Pressing any key terminates the screen dump.

There is also a monitor jump vector (see Section G) which activates screen dump under program control.

AUTOBOOT

Upon either power-up or warm initialization, the monitor scans both the keyboard and physical drive A. If a disk is present (or inserted), the monitor will proceed with an operating system cold boot. If no disk is inserted in drive A and a key is pressed, the monitor will turn off the drive, display a help menu, and prompt ("÷") for a command.

SPECIAL KEYS

Shown in the table below are the default values of the special keys recognized by the monitor, along with their functions.

CTRL+	Hex Code	Function
BACKSPACE	88	Toggle clock display on/off
ESC	9B	Abort procedure activated (may be disabled)
HELP	9E	Send contents of screen to printer

E. Resident Monitor

When the system is powered-up or system re-initialization occurs, a keyboard/physical drive A scan takes place until either a disk is present in drive A or a key is pressed. If a key is pressed, the Resident Monitor becomes active. There are only seven commands in the monitor (due to the 4k ROM size limitation) which are useful for general display or debugging.

Each command in the Resident Monitor starts with a single letter followed by either one or two parameters which are separated by either a blank or comma. All commands (with the exception of Boot and Help) are processed when the RETURN key is pressed. Parameters shown within angle brackets "< >" are required; parameters within "[]" are optional. ALL parameters are in hexadecimal unless otherwise specified.

Included below is a detailed description of each resident monitor function.

Table 1. Monitor Commands

Command	Format
Boot system disk	B <drive>
Dump memory	O [start address]
Go to address	G <execution address>
modify Memory	M <start address>
modify Port	P <port>
eXtended memory test	X <start address> <end address>
Help menu	?

BOOT: Cold boot of operating system from disk in the designated drive . Drive can be any letter A-D and will boot the designated drive. When a physical drive other than A is selected, that drive becomes logical drive A and logical drive [drive] maps into physical drive A.

For example, before the BOOT command, the logical drives mapped into physical drives as: A -> A, B -> B, C -> C, and O -> O. After a command "B B", the logical to physical map shows: A -> B, B -> A, C -> C, and O -> O.

OUMP: Dumps the contents of memory. If [start address] is specified, one page (256 bytes) will be dumped beginning at [start address]. If not, one page will be dumped starting from the last address of the most recent dump.

The format of the display is as follows:

aaaa dd dd dd dd dd dd dd dd dd dd dd dd dd dd dd dd cccccccccccccccc

where   aaaa is the starting address of the line in hex;
          dd is the value of memory at the given location;
          c is the ASCII character for the same position;
          characters which cannot be printed are designated by
          a period (.).

For example, if a line like the following was displayed

0150 00 01 48 65 6C 6C 6F 00 13 05 FE 00 00 00 00 00 ..Hello........

we know that location 0151H contains 01H, a string "Hello", followed by a carriage return starts at 0152H, and 0FEH is the value of location 015AH.

GO: Go execute the routine at <execution address>. GO is programmed such that a RETurn instruction can be used to re-enter the monitor.

MOOIFY: Modify memory starting at <starting address>. This command steps sequentially through memory allowing you to modify the value at the displayed location. Each location is displayed as

          aaaa dd

where aaaa is the memory address
      dd is the value at that location

The cursor waits at the end of the line for your input. To change the contents, you can enter either:

    (1) a two digit hexadecimal number,
    (2) a one digit hexadecimal number followed by a RETURN .
or (3) a single quote (') followed by any character.

In all cases, the monitor automatically advances to the next address.

If you do not wish to change the contents, pressing the <SPACE BAR> will re-display the contents of the current address. Pressing either <RETURN> or <+> will advance to the next location (leaving the current value unchanged) while <-> decrements the address. Pressing any other key (or invalid hexadecimal number) terminates the MODIFY command.

For example, assume that you wanted the contents of 0207H to be
18H, 208H to be 3, and 20AH to be 'Z'.   The sequence would
proceed as follows:

```
M207              --- Enter command
0207 00 18        --- Value was 00; enter 10 (no  RETURN )
0208 FF 3         --- Enter 3 followed by  RETURN
0209 FE           --- Skip this with a  RETURN
020A 27 'Z        --- Enter an ASCII 'Z' (no  RETURN )
020b 11 .         --- End of modify
```

PORT: Inputs the value of the <port , displaying it in
hexadecimal. Results are displayed as:

       pp dd

where pp is the hexadecimal port number
      dd is the value of the input port

The monitor waits at the end of each line for a keyboard
response.   Pressing the <SPACE OAR> will re-input and re-display
the current port. Pressing either <RETURN> or <+> will increment
to the next port address; <-> will decrement to the previous port
address.   Entering a hexadecimal number or ASCII character as
described in MODIFY will OUTPUT that value to the port displayed
and does NOT advance the port address.   Any other key terminates
the PORT command.

EXTENDED MEMORY TEST: Perform extended memory test from <start
address> to <end address>.   The specified range may not extend
into the monitor (to keep from destroying the monitor code).   The
test is very fast and thorough, performing a rolling one fill,
rolling zero fill, and 9-bit walking bit test.   The memory test
destroys the previous contents of memory, leaving every location
cleared (set to zero).

HELP MENU: Pressing the '?' (question mark) at the prompt will
bring up the Help menu which briefly describes each command.

F. Hardware Considerations

In this section, a description of the system data port as well as
the PRINTER, COMM, and General Purpose Parallel ports are
presented.   Instructions for modifying your Xerox system for
blinking/inverse video operation and attaching a bell are
included.

The system data port in the X120 is a bit-mapped parallel output
port which is configured similiar to the Kaypro, but is different
than the Xerox 820. The table below describes each bit.

Table 2.   System PIO Bit Description
(Port Address 1CH)

Bit #	Name	Description
7	BANK	Memory bank: 0 = RAM, 1 = ROM/Video
6	MOTOR	Motor line: 0 = on, 1 = off
5	DENSITY	Density line: 0 = double, 1 = single
4	BELL	Bell trigger normally low, goes high nonentarily when CTRL+G (07) is sent to VIDOUT or a call is made to K800UT.
3	VATT	Video attribute: 0 = inverse, 1 = blinking
2	SIDE	Side select: 0 = side 0, 1 = side 1
1	DSEL1	Drive select bit 1
0	DSEL0	Drive select bit 0: The physical drives nap as follows:

Drive	DSEL1	DSEL0
A	0	1
B	1	0
C	0	0
D	1	1

With the exception of bits 3 and 4 (VATT and BELL), the remaining
bits are defined when the X120 board is installed.   Implementing
the functions on these two bits requires some hardware
modification to the Xerox system.

IMPLEMENTING THE BELL

The BELL function can be implemented by attaching a one-shot to
the BELL bit (U105, pin 10) which in turn drives a piezo-electric
buzzer or similiar component.   A schematic is shown on the next
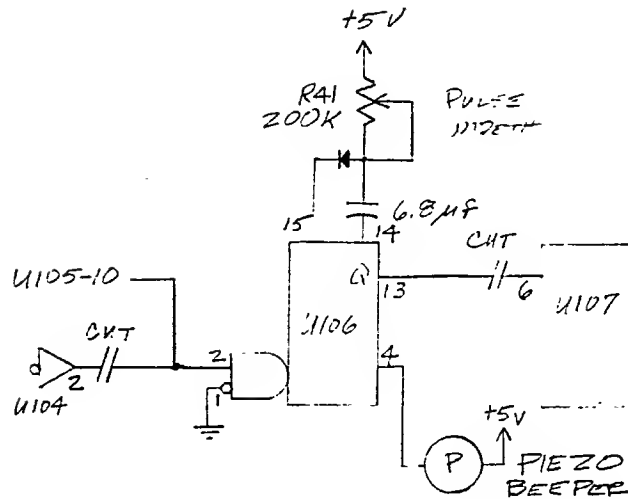page.

Figure 1. BELL Hardware Modification

IMPLEMENTING THE VIDEO ATTRIBUTE

The Plus2 ROMs have the option of using bit 3 of the system PIO as the video attribute, such as selecting between blinking and inverse video. With the inverse video modification installed, special characters can be displayed either as black characters on a white background or as blinking characters. Changing the system bit as described in Table 2 allows switching between the two video attributes; hence, special characters will either be inverse or blinking, but never both. Video attribute (normal versus special characters) is changed by sending an ESCape sequence to the video routine as described in Tables 10 and 11.

The hardware installation is fairly complicated, and should only be attempted if you have had experience modifying boards from wire lists or schematics. The modification also requires that your CRT (monitor) have fairly good bandwidth, as inverse video is much more susceptible to smearing (white into the black areas). Smearing is occasionally caused by the video overdriving the monitor, and can sometimes be remedied by placing a pull-down resistor on the raw video signal (TTL separated-sync) at the CRT end. The best value for this pull-down can be determined using a low value (500 ohm - 1K range) variable resistor, adjusting to

best clarity, and replacing it with a fixed resistor of similiar value.

The 629 (Etch 1) and 664 (Etch 2) Xerox boards have slightly different modifications as changes were made in the circuitry and timing between the two boards. Check the part number etched on the board near J4 to determine the version. A schematic showing the modification is shown in Figure 2.

BigBoard numbering on the video circuitry is different than either Xerox board, so adjustments must be made in the installation of the inverse video modification. A detailed description of the modification for the BigBoard appeared in the December 1981 issue of Micro Cornucopia.

DETAILED INSTRUCTIONS - 629 board

1. Cut trace going to U32 pin 10. Cut on bottom side of board near pin 10 or on top of board between C48 and C49 silkscreens.

2. Cut or remove field mod wire between U90 pin 6 and U34 pin 2. If the field mod does not go to U34, make note of the chip and pin number of its destination as you will need to connect to it later.

3. Cut trace between U105-12 and U105-21. The trace is under the chip, but also appears on the bottom of the board for about 3/4 of an inch.

4. Install a 74LS86 in spare chip location at U36. Note that the location is for a 16-pin chip and the 74LS86 has 14 pins. Install pin 1 on chip to pin 1 location on the board.

5. Jumper new U35 pin 7 to U35 pin 8 hole to pick up ground.

6. Install the following eleven jumpers:

            a. U35-14 to U35-13
            b. U35-12 to U105-12
            c. U35-11 to U94-1
            d. U94-2 to U83-11
            e. U94-3 to U91-11
            f. U35-10 to U90-6
            g. U35-9 to U91-10
            h. U35-8 to U34-2   ; or to the same pin as field
                                    ; mod previously went to
            i. U94-13 to U83-11   ; or U94-13 to U94-2
            j. U94-12 to U105-12
            k. U94-11 to U32-10

7. Configure your system with P2CNFG to indicate hardware mod has been completed.

DETAILED INSTRUCTIONS - 664 board

1. Cut trace going to U32 pin 10. Cut on bottom side of board near pin 10 or on top of board between C48 and C49 silkscreens.

2. Cut trace between U90-6 and U45-2.

3. Cut trace between U105-12 and U105-21. The trace is under the chip, but also appears on the bottom of the board for about 3/4 of an inch.

4. Install a 74LS86 in spare chip location at U3G.

5. Install the following eleven jumpers:

    a. U35-14 to U35-13
    b. U35-12 to U105-12
    c. U35-11 to U94-1
    d. U94-2 to U83-11
    e. U94-3 to U91-11
    f. U35-10 to U90-6
    g. U35-9 to U91-10
    h. U35-8 to U45-2
    i. U94-13 to U83-11   ; or U94-13 to U94-2
    j. U94-12 to U105-12
    k. U94-11 to U32-10

7. Configure your system with P2CNFG to indicate hardware mod has been completed.
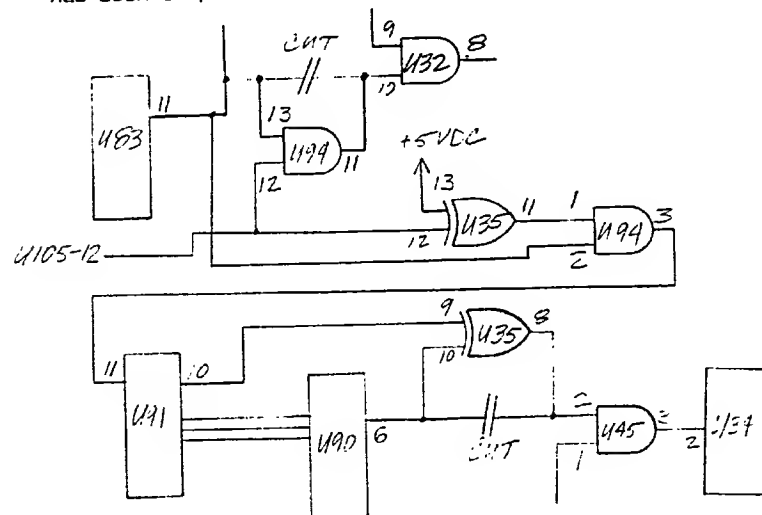
Figure 2. Video Attribute Modification

COMM and PRINTER PORT DESCRIPTIONS

Included below is the pinout for the PRINTER and COMMuncations RS-232 ports should you choose to attach a modem or a serial printer to your Xerox system. Only the important data and control lines are described.

On the Xerox, the serial PRINTER port is permanently wired for the standard DTE configuration. The BigBoard has this port located on connector J3 and is fully strappable. This port should be strapped to conform to the cable and RS232 connector on your printer; the description below only applies to a BigBoard strapped for DTE operation.

Table 3. PRINTER Port Description

PRINTER RS-232 port is the middle 25-pin connector (Xerox)
and connector J3 on the BigBoard
(Control port 07H; data port 05H; baud rate 0CH)
(Direction is with respect to the Xerox 820.)

Pin #	Name	Direction	Description
1	GND	---	Ground
2	PRCV	In	Receive Data
3	PXMIT	Out	Transmit Data
4	PCTS	In	Clear-To-Send
5	PRTS	Out	Request-To-Send
6	PDSR	Out	Data-Set-Ready
7	GND	---	Ground
8	PDTR	Out	Data-Terminal-Ready
20	PDCD	In	Data-Carrier-Detect

Table 4. COMM Port Description

COMM RS-232 port is the end 25-pin connector (Xerox)
and connector J4 on the BigBoard
(Control port 06H; data port 04H; baud rate 00H)
(Direction is with respect to the Xerox 820.)

Pin #	Name	Direction	Description
1	GND	---	Ground
2	MXMIT	Out	Transmit Data
3	MRCV	In	Receive Data
4	MRTS	Out	Request-To-Send
5	MCTS	In	Clear-To-Send
6	MDSR	Out	Data-Set-Ready
7	GND	---	Ground
8	MDCD	In	Data-Carrier-Detect
20	MDTR	Out	Data-Terminal-Ready

PARALLEL PORT DESCRIPTION

Should you choose to attach a Centronics-type parallel printer to your Xerox system, there are three different methods available:

    (1) the Xerox Standard bit-mapped parallel interface,
    (2) single port interrupt driven A-side,
or (3) single port interrupt driven B-side.

The first method should only be used if you already have the cable available or need to connect with a single-density Xerox 820 which has the parallel driver installed. Polling is required to obtain printer status and both General Purpose PIO ports are used.

The second and third methods are preferred as only half of the General Purpose PIO is used freeing one port for other applications. Further, printer status is interrupt driven (since handshake is handled via the STROBE and READY lines) which simplifies the interface.

In the standard Xerox method, the A-side of the PIO (data port 08H and control port 09H) is used for data output with the B-side (data port 0AH and control port 0BH) implementing the handshake. The "A-side" and "B-side" single-port methods use only the respective control and data ports. Of the three methods, the "A-side" single-port method is the easiest to install. However, some printers will not function with the "A-side" or "B-side" methods due to conflicts between the STROBE and READY signals. In these cases, it will be necessary to use the standard Xerox method.

Table 5. Parallel Port and Printer Description

Parallel Port is J3 on the Xerox
and J5 on the BigBoard
(Direction is with respect to the Xerox 820.)

Centronics connector	Signal	Direc	J5/J8 A-side	J5/J8 B-side	J5/J8 Std. Xerox
1	STROBE	Out	4	22	30
2	D0	Out	6	26	6
3	D1	Out	8	28	8
4	D2	Out	10	30	10
5	D3	Out	12	32	12
6	D4	Out	14	34	14
7	D5	Out	16	36	16
8	D6	Out	18	38	18
9	D7	Out	20	40	20
10	ACK	In	NC	NC	40
11	BUSY	In	2	24	34

NOTES:

1. Pins 19-29 of the Centronics connector should be connected to the odd numbered pins of J5/J8 for grounding.

2. The 629A version of the Xerox 820-1 does not have the required grounds on the odd numbered pins of J8. These grounds MUST be installed before using the J8 connector (EXCEPT in cases where you have a stock Xerox parallel printer cable with the compensating ground strap).

3. The Centronics 36-pin connectors are numbered consecutively up each side, whereas J5/J8 is numbered alternately from side to side. Do not connect any pins other than the ones listed on the previous page to the Centronics connector. These pins are fairly standard on most printers. The pins from 12 to 18 and 30 to 36 may be used for anything from test signals to DC power, and may do damage to your printer and Xerox board if they are connected.

In order to configure the PIO for the type of printer interface desired, the strapping port J11 on the Xerox and J83 on the BigBoard must be set properly. These straps define the data direction as well as STROBE/READY polarity. When unstrapped, STROBE accepts a high pulse and READY sends a low pulse.

Table 6. Parallel Port Strapping Options

Straps for J11 on the Xerox
and J83 on the BigBoard
(+STROBE and -READY are optional depending on your printer.)

Signal	A-side Xerox	A-side BigBoard	B-side Xerox	B-side BigBoard	Std. Xerox Xerox	Std. Xerox BigBoard
DATA OUT	9-10	15-16	11-12	9-10	9-10	15-16
DATA OUT	17-18	13-14	5- 6	11-12	17-18	13-14
DATA OUT	NC	NC	NC	NC	5- 6	11-12
+STROBE	13-14	7- 8	15-16	3- 4	NC	NC
-READY	7- 8	1- 2	3- 4	5- 6	NC	NC

The software drivers for your parallel printer as well as your default printer (serial or parallel), are selected when you configure your system. Although only a single printer may operate under CP/M and QP/M, the IObyte allows switching between a serial and parallel printer. This effectively gives two printers which can be chosen under program control or with STAT or QSTAT.

G. Monitor Entry Points

This section details the monitor entry points in the Plus2 v0.01 monitor.

PLUS2 ROM Entry Points

The PLUS2 ROM entry points are compatible with the Kaypro x-83 or earlier ROMs allowing the Xpro-8+2 to run programs specific to the Kaypro series.   The Plus2 BIOS makes extensive use of the calls.

Table 7. Plus2 ROM Entry Points

How to Read

'Locn' is address in hex. 'Entry' shows registers and their values. 'Exit' shows useful data contained in registers upon return. 'Registers' shows all registers altered: '8080' = AF,BC,DE,HL and 'all' is every register on the Z80 except the IY and Z80 secondary registers (accessed with EXX and EX AF,AF').

Locn	Label	Name	Values/Description
0000	COLD	Cold boot	Entry: none Registers: all
			Exit: DOES NOT EXIT
0003	INITDSK	Init Disk	Entry: none Registers: AF
			Exit: none
0006	INITVID	Init Video	Entry: none Registers: AF
			Exit: none
0009	INITDEV	Init Plus2	Entry: none Registers: 8080
			Exit: none
000C	HOME	Home drive	Entry: none Registers: C,HL
			Exit: none
000F	SELDSK	Select disk	Entry: C = drive code
			Exit: HL = DPH address
			A = drive status
			Registers: all
0012	SETTRK	Set track	Entry: C = track
			Exit: none Registers: HL
0015	SETSEC	Set sector	Entry: C = sector
			Exit: none Registers: HL
0018	SETDMA	Set DMA	Entry: DC = DMA address
			Exit: none Registers: none
001B	READ	Read sector	Entry: none Registers: all
			Exit: A = status
001E	WRITE	Write sect.	Entry: none Registers: all
			Exit: A = status

0021	SECTRAN	Sect. xlate	Entry: BC = sector
			Exit: HL = xlated sector
			Registers: AF,BC,HL
0024	DISKON	Motor on	Entry: none Registers: AF,CC,HL
			Exit: none
0027	DISKOFF	Motor off	Entry: none Registers: AF
			Exit: none
002A	KBDSTAT	Keybd stat	Entry: none Registers: AF
			Exit: keyboard status
002D	KBDIN	Keybd input	Entry: none Registers: HL,AF
			Exit: keyboard char
0030	KBDOUT	Keybd out	Entry: none Registers: 8080
			Exit: none
0033	SIOSTI	Serin stat	Entry: none Registers: AF
			Exit: A = serial input status
0036	SIOIN	Serial in	Entry: none Registers: AF
			Exit: A = serial input char
0039	SIOOUT	Serial out	Entry: C = char
			Exit: none Registers: AF
003C	LISTST	List stat	Entry: none Registers: none
			Exit: none
003F	LIST	List out	Entry: none
			Exit: none Registers: none
0042	SERSTO	Serout stat	Entry: none Registers: AF
			Exit: A = status
0045	VIDOUT	Video out	Entry: C = char Registers: all
			Exit: none
0048	DELAY	Delay	Entry: B = delay count
			Exit: none Registers: D,DE,AF
004B	TIMDAT	Time/date	Entry: none Registers: HL
			Exit: HL = TIMDAT address
004E	SCRDMP	Screen dump	Entry: none Registers: all
			Exit: none
0051	FLUSH	Flush buff	Entry: none Registers: 8080
			Exit: A = status

A brief description of each entry point is included below:

COLD: Resets entire computer system and is ALMOST like pressing the RESET button. See Initialization, part C.

INITDSK: Resets the disk input/output buffer status to empty. Any pending write is lost. Useful to perform a "soft" disk reset.

INITDEV: Initializes the Plus2 system, including all I/O ports and high memory routines, such as the Xerox compatible monitor vectors and interrupt services.   A "hard" disk reset is performed to the initial single-density Xerox 820 compatible format, and all previous disk information is overwritten.

HOME: Sets track number to 0. No seek is actually performed until either a disk read or write occurs.

SELDSK: Selects logical drive in register C (value of 0 through 3, corresponding to drives A through D), with pre-select flag in E. Returns disk status in AF, C and HL. SELDSK is the heart of the disk routines and determines what type of disk (size, density, and format) is present in the drive.

Upon entry, register C contains the logical drive number (0-3), which is mapped into the physical drive. The LSB (low bit) of the E register determines whether a true select occurs. If the LSB of E is 0, the disk is treated as a new disk and its format is checked. If the LSB of E is 1, the disk is considered to have been selected before and no format check occurs.

Upon exit, the Z-80 Zero status flag indicates success (Z is set) or failure (Z is not set) except if the LSB of register E was 1, in which case the select is always successful. If the disk was selected without error, HL contains the address of the DPH (Disk Parameter Header). If an error occurs, HL is set to 0; the type of error encountered depends on the values in the A and C registers.

When an error occurs, the C register indicates the category as follows:

Table 8. Disk Error Categories

C = 0	disk error occurred, status in A register
1	quad disk installed in non-quad drive
2	unknown disk format encountered

When C is zero, disk status in the A register contains the type of disk error that occurred and is a bit-mapped error code as described below:

Table 9. Disk Error Code

	Bit	Read/Write/Seldsk/Seek
(hi)	7	drive not ready
	6	write protected (can only occur during write)
	5	write fault (can only occur during write)
	4	record not found/seek error
	3	crc error
	2	lost data/cannot seek track 0
	1	---
(low)	0	---

SETTRK: Sets the track number to the value in register C. No seek is actually performed until a disk read/write occurs.

SETSEC: Sets the logical sector number to the value in register C.

SETDMA: Specifies the DMA address where disk read/write occurs in memory. The address in register pair BC is used until another DMA address is specified.

READ: Reads the previously-specified logical sector from specified track and disk into memory at the DMA address. Note that on double-density disks, one physical sector may be composed of up to eight logical sectors, so a physical disk read may not actually occur. Returns disk status in A with zero indicating no error occurred and a non-zero value indicating an error as described in table 8.

WRITE: Same as above, but writes from memory to disk.

KBDSTAT: Simply returns status of keyboard queue. Returns 0FFH if a key is available, or 00H otherwise.

KBDIN: Gets character from keyboard buffer or waits for one, if none ready.

KBDOUT: A Kaypro compatible vector that sends a BEL character to the video entry VIDOUT.

SIOSTI: Returns status of SIO-B input port. Returns 00H if no character is ready, or 0FFH otherwise.

SIOIN: Fetches character from SIO-B input port, or waits for one if none is ready.

SIOOUT: Sends character to SIO-B output port.

LISTST: Dummy vector not implemented in Plus2, but included for Kaypro compatibility.

LIST: Dummy vector not implemented in Plus2, but included for Kaypro compatibility.

SERSTO: Returns status of SIO-B output port. Returns 0FFH if SIO-B is ready to accept a character for output, and 00H otherwise.

VIDOUT: Sends character in register C to video screen. All characters 20H (blank) to 7FH are directly displayed and screen scroll is done, if required. Characters below 20H are defined as control characters. The table below lists the control codes accepted and their meaning. Note that all other control characters and escape sequences are simply ignored, and screen display is not affected.

Table 10. Video Control Characters

Hex Code	Function
05	Set cursor character to next character sent. Cursor characters between 20H and 7FH are ignored.
07	Ding! Toggles bit 4 of PIO [U105 pin 10] momentarily high - you have to add your own buzzer/beeper
08	Backspace or cursor left (does NOT erase character)
09	Horizontal tab (8 columns each)
0A	Line feed or cursor down
0B	Cursor up
0C	Cursor right
0D	Carriage return
11	Clear to end of screen
17	Clear to end of screen (for Kaypro compatibility)
18	Clear to end of line
1A	Clear screen and home cursor
1B	Activate escape sequence
1E	Home cursor
1F	Display next character sent

Table 11. Video Escape Sequences

(ESCape character followed by)

Hex Code	ASCII Char	Function
28	(	Disable attribute display (characters normal)
29	)	Enable attribute display (characters blink/inverse)
2A	*	Clear screen
30	0	Set 7-bit keyboard mode
31	1	Set 8-bit keyboard mode
34	4	Set blinking attribute
37	7	Set inverse video attribute
3D	=	Set XY cursor position leadin (4 characters total). Whole sequence is: "ESCape, =, Y, X" where Y = row (0-23 dec.) + 20 hex and X = column (0-79 dec.) + 20 hex. Upper left of screen (home) is X = 0, Y = 0.
45	E	Line insert. Moves screen below cursor one line down and leaves cursor at present position (on the blank line).
51	Q	Character insert. Moves remainder of line one character right, inserting blank and leaving cursor over blank.
52	R	Line delete. Deletes line cursor is on, moving remainder of screen up to fill it. Blank line is left at bottom of screen.
54	T	Clear to end of line
57	W	Character delete. Deletes character cursor is on, shifting remainder of line left to fill space. Blank is put at end of line.
58	Y	Clear to end of screen

DELAY: A Kaypro compatible entry which performs a "B times 10 mSec" delay. The 10 mSec delay is preset for 4 MHz, but is re-initialized to the user-specified clock rate after boot. "B" is the value in the B-register and ranges from 1 to 256 decimal (0 is treated as 256).

TIMDAT: Returns HL register pair pointing to the DAY memory location. This is a very powerful entry point, as it indicates where a number of monitor variables are located. All values other then DAY are located relative to the HL register pair. Adding offset to the HL register gives access to these other locations. The table on the next page lists the accessible monitor variables:

Table 12. Location of Monitor Variables

The locations are relative to the address returned in HL after a call to TIMDAT.

Offset	Name	Description
HL - 08H	KBDMSK	Keyboard mask (7FH=7-bit, 0FFH=8-bit)
07H	SDK	Screen dump key
06H	AOK	Abort key
05H	CTK	Clock display toggle key
04H	CLKSPD	System clock (0=2.5, 1=4.0, 2=5.0 MHz)
03H	CLKDSP	Clock display (00H = off, 0FFH = on)
02H	TIKCNT	16-bit one second "tick"
HL + 00H	DAY	Day (01-31 decimal)
01H	MONTH	Month (01-12 decimal)
02H	YEAR	Year (00-99 decimal)
03H	HOUR	Hour (00-23 decimal)
04H	MINUTE	Minute (00-59 decimal)
05H	SECOND	Second (00-59 decimal)
08H	DSKMAP	Logical-to-physical drive map table
0AH	DFFDLY	Drive timeout (seconds)
0BH	RETRYM	Retry maximum - 1
0CH	MAXDRV	Maximum drive (1=A/B, 3=A/B/C/D)
0DH	DLYOFF	Sector Hole Count ÷ 2 when drives off
0EH	DLY5ON	SHC ÷ 2 when 5" select and drives on
0FH	DLY8ON	SHC ÷ 2 when 8" select and drives on
17H	CSRCHR	Cursor character

For example, after calling TIMDAT, one could obtain the cursor character by:

```
LD   DE,17H    ;offset from DAY location
ADD  HL,DE     ;point to the CSRCHR location
LD   A,(HL)    ;fetch cursor character into A
```

SCRDMP: Sends a copy of the screen display to the printer. If no system disk has been booted, Plus2 will use the PRINTER port as the LIST device. After boot, Plus2 will use whatever LIST is implemented in your BIOS. Any keypress terminates the screen dump.

FLUSH: Flushes disk buffers. Any pending disk writes are completed and the buffer flags are reset.

H. BIOS Features

The Plus2 BIOS implements the operating system interface (QP/M or CP/M), using the Plus2 ROMs for a majority of the tasks: console input/output, device initialization, and disk routines. However, the IObyte mapping, printer interfaces, and disk error recovery are controlled within the Plus2 OIOS.

It is STRONGLY recommended that any BIOS configuration be handled with the P2CNFG utility. P2CNFG contains the relocatable code for the BIOS and BOOT sector and is capable of configuring the BIOS for any system configuration (see section I).

Experienced users may still wish to modify the BIOS for a specific application; consequently, source code for the OIOS is provided. However, programmers should be aware that the BIOS cold boot routine should not be modified in any way. Adding program code to the tail end of the cold boot routine or modifying any other BIOS calls is allowed.

IOBYTE MAPPING

The IObyte is partially implemented within the Plus2 BIOS, mapping both the printer (LST:) and console (CON:) devices. The table below summarizes the bit mapping.

Table 13. IObyte Logical-to-Physical Device Map

Bit #	Name	Description
7	PTYPE	Printer type: 0 = serial, 1 = parallel
6	ECHO	Echo console output to printer: 0 = no echo, 1 = echo
1	COMM	COMM port as console: 0 = no, 1 = yes
0	KBDVIO	Keyboard/video as console: 0 = no, 1 = yes

This unique IObyte mapping allows for some interesting combinations:

- both the COMM port and keyboard/video can be the console at the same time

- console I/O can be totally disabled

- both a serial and parallel printer can be attached with printer select via PTYPE

- console output can be echoed to the printer

The IObyte is set upon cold boot and can be changed directly (the IObyte is located at 0003 in memory) or via QSTAT/STAT. The logical-to-physical device names in QSTAT/STAT are assigned as follows:

Table 14. QSTAT/STAT Device Names

Logical	Physical	Description
CON:	TTY:	Console I/O disabled
	CRT:	Keyboard/video
	BAT:	COMM port
	UC1:	Both keyboard/video and COMM
LST:	TTY:	Serial printer
	CRT:	Serial printer w/console echo
	LPT:	Parallel printer
	UL1:	Parallel printer w/console echo

Reader and punch are implemented in the BIOS as the COMM input and output ports, respectively.

DISK ERROR RECOVERY

When a disk error occurs during read and write, Plus2 makes several attempts to recover from the error, if possible. If the error is still present, the BIOS displays a message like:

    BIOS err on A: Acpt Ignr Rtry?

Pressing the 'R' key forces the BIOS to make another read/write attempt. The 'A' key will return the error to the calling routine (most likely the DOS); 'I' will also return to the calling routine, but will return a success code as if no error occurred.

Disk errors can occur for a number of reasons, but three appear to be most common. If an error occurs, first verify the drive door is completely closed. Also, if an error occurs during write, check the write-protect label: it should be present to write to 8" disks and absent to write to 5.25" disks. Finally, if you have changed disk types (number of sides and/or density), a error can occur.

If you are running under QP/M, errors due to disk changes are far less frequent than running under CP/M (the BIOS was written to take advantage of QP/M's automatic disk re-log). However, if an error does occur, simply 'A'ccept the error and the disk will be re-logged automatically. If you are running under CP/M, ctrl+C is your only way out.

I. Configuring Plus2 for your System

The Plus2 ROMs were designed to support a variety of Xerox 820 configurations such as different keyboards, floppy step rate, and other items. Customization is accomplished through the P2CNFG utility which has the following major features

- generates Plus2 bootable disk from either a single-density Xerox 820 system disk, Xpro system disk, or another Plus2 system disk

- allows you to change the BIOS/BOOT size by specifying the new CP/M or QP/M system size desired

- user-specified hardware options, including system clock rate, type of parallel and serial printers, keyboard special keys, Ferguson RAMcard, and type of disk drives

- user-specified software options, including clock display, floppy step rates, serial printer protocol, keyboard mode, drive select and motor delays, and video attribute

The P2CNFG utility guides you through menus which allow you to customize Plus2 for your particular system and can be aborted at any time. The options chosen are stored onto the boot sector of a Plus2 system disk. Every time a cold-boot is performed, Plus2 will be reset to the values you chose for your system.

J. Monitor Memory Usage

The memory usage of RAM in the Plus2 is at the absolute minimum.
All monitor routines are in ROM, with only essential drivers and
interrupt service routines located in RAM. A general memory map,
specific interrupt vector address map, and disk parameter map
follow:

Table 15. Monitor Memory Usage

Range (Hex)	Description
F400-F600	RAM resident monitor routines
F600-F8FF	Disk Parameter Headers, Disk Parameter Blocks, checksum area, allocation area, and other disk variables
F900-FCFF	1024 byte disk buffer
F000-F07F	Scratch directory buffer
F080-FEFF	RAM resident interrupt service and disk routines
FF00-FFFF	Monitor variables and stack area

The following locations contain the addresses of the specified
interrupt service routine. For example, CTCV3 (FF18H) contains
the address of TIMER which increments the clock.

Table 16. Plus2 Interrupt Vector Table

Range (Hex)	Variable	Used	Description
FF00-FF01	SIOVB0		SIO port B xmit buffer empty
FF02-FF03	SIOVB1		SIO port B ext/status change
FF04-FF05	SIOVB2		SIO port B receive data available
FF06-FF07	SIOVB3		SIO port B special receive condition
FF08-FF09	SIOVA0		SIO port A xmit buffer empty
FF0A-FF0B	SIOVA1		SIO port A ext/status change
FF0C-FF0D	SIOVA2		SIO port A receive data available
FF0E-FF0F	SIOVA3		SIO port A special receive condition
FF10-FF11	CTCV0		CTC channel 0 interrupt
FF12-FF13	CTCV1		CTC channel 1 interrupt
FF14-FF15	CTCV2	x	CTC channel 2 interrupt
FF16-FF17	CTCV3	x	CTC channel 3 interrupt
FF18-FF19	SYSVA	x	System PIO port A interrupt
FF1A-FF1B	SYSVB	x	System PIO port B interrupt
FF1C-FF1D	GENVA		General PIO port A interrupt
FF1E-FF1F	GENVB		General PIO port B interrupt

Whenever a disk is successfully selected, the Disk Parameter
Header (address) is returned in the HL register pair.   All disk
information for a specific drive is continuous and is accessible
by offseting the HL register as detailed below:

Table 17. Disk Parameter Map

Hex Offset	Name	Description
HL + 00	DPH	Disk Parameter Header (16 bytes)
10	DPB	Disk Parameter Block (15 bytes)
1F	STRTSC	Starting sector number on track (either 00 or 01)
20	STRTSC2	Additional starting sector number offset for side 1 (usually 0)
21	DENS	Density (00 = double, 20 = single)
22	SECMSK	Sector mask - depends on sector size (128- 0, 256- 1, 512- 3, 1024- 7) (sector mask is 0, 1, 3, or 7)
23	SECSIZ	Sector size (128, 256, 512, 1024) (2 bytes)
25	DFLAG	Drive flag is bit mapped. Bit is 1 if value true, otherwise 0. bit 7 = is a quad DRIVE (auto-set) 6 = locked format* 5 = 8" DRIVE is single-sided 4 = 8" DRIVE (0 for 5.25) 3 = quad DISK present 2 = is a double-sided DISK 1,0 = step rate (0-3)
26	DTRACK	Current track number of drive
27	DFLAG2	Disk flag 2. Only high bit matters at present: bit 7 = 1 if is special Xerox double-sided format, else 0
28	ALLOC	Allocation vector (80 bytes)
7E	CSV	Checksum vector (64 bytes)

*A "locked" format protects the current disk format. In essence,
Plus2 assumes the drive has been selected before WHETHER IT HAS
OR NOT. This is useful for setting a drive to an unknown Plus2
format (e.g. Ampro) without requiring additional memory or a
complex interchange program. A disk format remains "locked"
until specifically unlocked or a RESET occurs.   P2DSKDF uses the
lock bit to prevent Plus2 from tampering with its installed disk
formats.

K. Special Utilities

MICROCode Consulting has written a number of useful utilities for the Plus2 ROMs. All have on-screen prompting (just execute the utility without any parameters), and are easy to use. NONE of the below utilities perform any major system change unless specified by the user; hence, it is safe to run the utilities just to obtain a help/description menu.

ABRTKEY.COM renders the abort key inoperative; reset can only be performed by pressing the RESET button.

AUTOBOOT.COM is used to enter, erase, or change the cold-boot execution program on a Plus2 system disk.

FORMAT.COM is used to initialize a disk for use under the Plus2 system or another system. A total of 13 formats are currently supported.

LOCK.COM is used to "lock" a given format on the specified disk. A format remains locked until it is specifically unlocked with LOCK.

P2CNFG.COM is used to configure or re-configure a Plus2 system disk. Refer to section I for more information.

P2DSKOF.COM is used to install other disk formats and "lock" them, until the format is specifically removed by P2DSKOF.

SETCLK.COM is used to set or reset the monitor real-time clock whenever desired. QP/M users have the ability to automatically execute this program on cold-boot, while still leaving any auto-boot program intact.

SYSGEN.COM is used to move a system image to any system disk from either another system disk, disk file, or system image in memory. Since the Plus2 system internally detects S.2S and 8 inch disk sizes, the same Plus2 system works on either disk size. A message is given during SYSGEN containing a system description (Plus2 or another system) and the system size. The Plus2 system image can reside on any of: 5.25" single-density, 8.00" single-density, 5.25" Kaypro formats (single-/double-sided and quad), and 8.00" Xpro 16.